#17/Aff
Drawy
3/24/04

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail in an envelope addressed to:
Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450
on Nov. 11, 2003

Sherri Sitzmann
(name of person making deposit)

(signature)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: Anthony P. Peirce, et al.	Attorney Docket No: 56.0468
Serial No.: 09/301,961	Group Art Unit: 2123
Filed: April 4, 1999	Examiner: Day, Herng-Der
For: Method and Apparatus for Hydraulic Fracturing Analysis and Design	

AFFIDAVIT UNDER 37 CFR 1.132

Commissioner of Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

Eduard Siebrits, being duly sworn, does hereby depose and say as follows:

I am one of the co-inventors of the above-identified patent application.

I received and hold a Bachelor of Science Degree in Civil Engineering from the University of Cape Town, South Africa in 1984; and I received a Masters of Science Degree in Civil Engineering from the University Cape Town, South Africa in 1987, with a thesis entitled "Three-Dimensional Elastodynamic Shear Fracture Propagation and Ground Motion Simulation Model". I received the degree of Doctor of Philosophy in Geo Engineering from the University of Minnesota, Minneapolis in 1992, with a thesis on "Two-Dimensional Time Domain Elastodynamic Displacement Discontinuity Method with Mining Applications";

I was employed from 1987 to 1995 by COMRO Rock Engineering, Johannesburg and CSIR Mining Technology, Johannesburg, working on 2D and 3D numerical modeling of rockburst processes in deep gold mines, including back analysis of a rockburst accident, developing numerical models based on boundary element, finite element, and finite difference methods;

I have been employed since 1995 by the Dowell Division of Dowell Schlumberger Inc, that later merged with Schlumberger Technology Corporation; working on 2D fluid flow models, 2D and planar 3D hydraulic fracturing simulators, refracture reorientation in tight gas wells, and comparisons of commercially available planar 3D simulators in the petroleum industry;

I have contributed to more than 20 publications, as shown by the attached list;

I am presently employed by Schlumberger Technology Corporation, the assignee of the above-identified application, in Sugar Land, Texas and currently the Team Leader of the Modeling & Mechanics Group of the Well Services division;

In the present affidavit, I address two issues raised in the Final Office Action issued on September 11th, 2003:

- a schematic comparison of the P3D and PL3D models; and
- the applicability of the GOHFER model

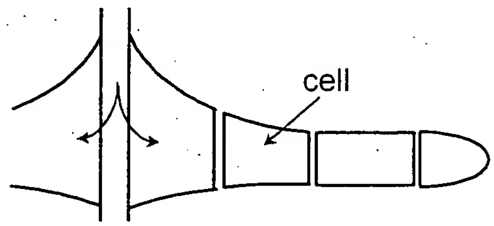
P3D and PL3D Models

There are numerous published texts in the open literature on the differences between pseudo 3D (P3D) and planar 3D (PL3D) hydraulic fracturing models.

As is known by those skilled in the art of writing hydraulic fracturing simulators, P3D models account for layered reservoirs in a less accurate manner than PL3D ones because elastic properties are averaged over the fracture height, and the growth of the hydraulic fracture is based on a 1D mesh in the fracture length direction (e.g., see Figure 1). FracCADE, for example, uses a P3D mesh.

In contrast, PL3D models take into account the properties of each layer, and are based on 2D meshes (e.g., see Figure 2) to describe the fracture geometry. They are thus considered to be more accurate by all users of such simulators. P3D simulators are useful for layered reservoirs when elastic properties do not vary significantly between layers, and where bounding layers provide confinement to prevent runaway height growth. PL3D simulators are typically not bound by these limitations. In addition, there are certain types of problems that P3D simulators are not capable of modeling, such as those involving reservoirs that contain thin hard layers. In such cases, so-called "pinch points" (i.e., regions of significantly reduced fracture width) are likely to develop and can typically be modeled by a more rigorous PL3D model, but not by a P3D one.

Schematic of pseudo 3-D model



- **Break fracture into separate blocks, or "cells"**
- **Enforce fundamental physical equations for each cell**
- **Enforce mass balance across cells**

Figure 1: An example of a P3D model, where the fracture length is discretized into elements or cells (i.e., a 1D mesh). The basic equations are enforced on each cell.

Schematic of planar 3D frac model

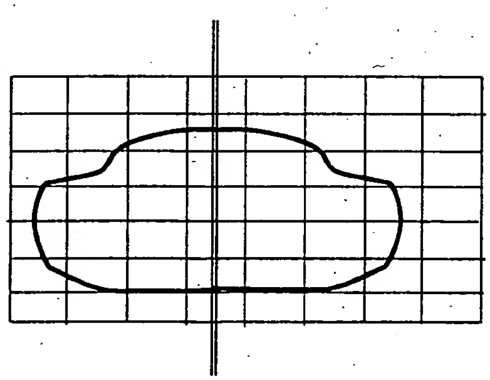


Figure 2: An example of a PL3D mesh, where the fracture surface is discretized into a 2D mesh of rectangular elements.

Applicability of GOHFER model

The following plots are numerical results of uniformly pressurized cracks in layered materials that show the accuracy of the Peirce/Siebrits simulator (that is a part of patent application 56.0468) and the inaccuracy of GOHFER. Note that all the simulations in this section exclude the effects of fluid flow. These results are all based on the simplifying assumption of constant fluid pressure in the fracture.

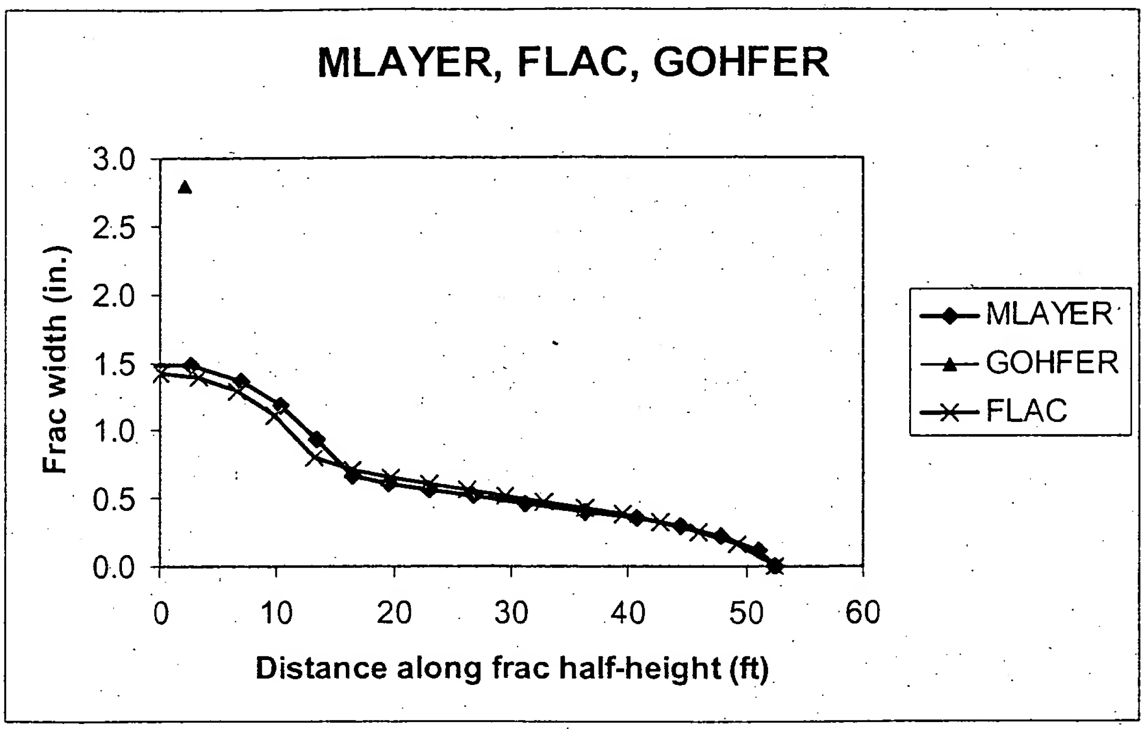


Figure 3: Plot of fracture width vs. distance along fracture half-height for uniformly pressurized fracture located in a three-layer material under conditions of plane strain. Layer interfaces between contrasting materials are oriented orthogonal to the fracture surface. The central softer layer has lower Young's modulus than the two bounding ones (elastic contrast is 10-fold between the softer and harder materials). Fracture half-height of zero corresponds to the center of the fracture (i.e., only half the fracture height is shown due to symmetry about zero). The MLAYER result is due to Peirce/Siebrits, and the FLAC result is obtained from running a well known commercially available simulator, based on a (much slower) finite difference method, that matches MLAYER. The peak width is 1.5 inches in the three-layer case, and this differs substantially from the equivalent GOHFER result of approximately 2.8 in. peak width.

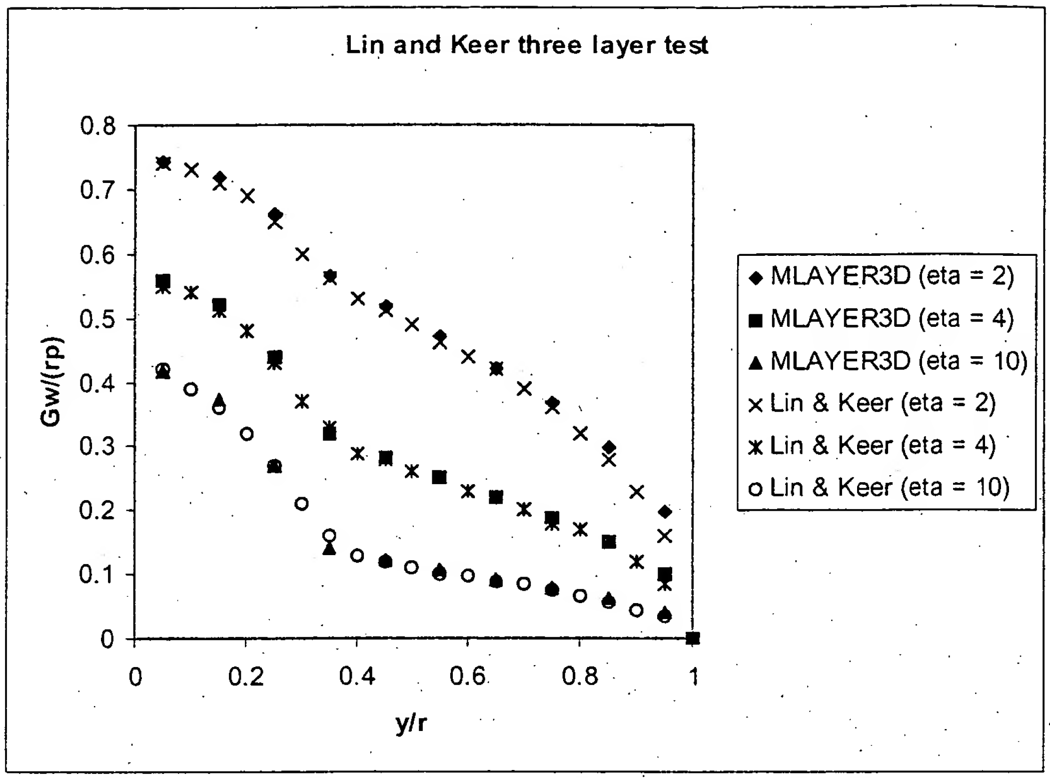


Figure 5: Plot of normalized fracture width vs. normalized radial distance along the fracture, for uniformly pressurized penny-shaped fracture in 3D space, with fracture spanning two layer interfaces, and oriented orthogonal to them. MLAYER3D results are from a PL3D Peirce/Siebrits simulator, and Lin & Keer results are published in the open literature, and are considered to be accurate. Parameter ETA defines the contrast in elastic Young's modulus between the central softer layer and the bounding harder ones. MLAYER3D results closely match the Lin & Keer ones in all cases.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Eduard Siebrits

Sworn and subscribed before me
this 11th day of Nov, 2003

Sherri Sitzman
Notary Public

SHERRI SITZMANN
Notary Public, State of Texas
My Commission Expires
05/28/2005

NOTARY PUBLIC STATE OF TEXAS